Improved Conditioning for Biosolids Dewatering in Wastewater Treatment Plants

by

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Date: 15/07/2015

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NOMENCLATURE

G	=	Velocity gradient (s^{-1})
g	=	Times gravity
R^2	=	Correlation coefficient

LIST OF ABBREVIATIONS

ADS	Anaerobically Digested Sludge
AEDS	Aerobically Digested Sludge
BOD	Biochemical Oxygen Demand
CST	Capillary Suction Time
DS	Dry Solids
MCI	Modified Centrifugal Index
OPD	Optimal Polymer Demand
PD	Polymer Demand
rpm	revolution per minute
sCOD	Soluble Chemical Oxygen Demand
sP	Soluble Protein
sPS	Soluble Polysaccharides
SS	Suspended Solids
VS	Volatile Solids
WAS	Waste Activated Sludge
WWTP	Wastewater Treatment Plant
ZP	Zeta Potential

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ABSTRACT

The aims of this study were to (i) characterize different sludge types, which were anaerobically digested sludge (ADS), aerobically digested sludge (AEDS) and waste activated sludge (WAS) obtained from 3 Wastewater Treatment Plant (WWTP) of Sydney Water, Australia, for the purpose of determining feasible correlations of sludge properties with polymer demand (PD) for sludge conditioning and dewatering, and (ii) apply a new method, namely "Modified Centrifugal Index" test, in evaluating the dewaterability of these sludges after dewatering as well as determining optimal polymer demand (OPD). Besides polymer conditioning, the study also (iii) investigated several conditioning methods using other chemicals such as dual conditioning (Cationic/Anionic polymers and Iron/cationic polymer conditionings) and Fenton oxidation for improving/maintaining sludge dewaterability while reducing the chemical cost of sludge treatment.

It is believed that a comprehensive understanding of the sludge characteristics is essential for optimizing the dewatering process. The study results of sludge characteristics show that ADS required the highest polymer demand for conditioning compared to the other sludge types studied. On the contrary, WAS required the least amount of polymer. The study also proved that there were good correlations between soluble biopolymers (mainly protein and polysaccharides) and OPD, which highlights the major role of soluble biopolymers in deciding polymer demand for sludge conditioning. Besides, these relationships could provide helpful information on suitable polymer types and dosages for an effective sludge conditioning.

Although CST is the most common parameter to evaluate the solid – liquid separation ability, it is often not a reliable indicator. In this study, a modified laboratory – scale centrifuge apparatus was employed. The experimental results show that Modified centrifugal index (MCI) test can be successfully used to evaluate the dewaterability of different sludge types with and without conditioning by estimating the maximum solids cake achievable by the centrifuge. After conditioning and centrifuge, solids contents were increased from 16% to almost 30% for ADS and from 19% to 23% for WAS. These values were similar to the results observed in real WWTPs. This demonstrates that MCI measurement is good to estimate the final cake concentration as well as simulate the real centrifuge process. This method can also help to determine optimal polymer demand (OPD) required for sludge conditioning.

Based on both CST and MCI tests, lower polymer doses than currently used ones were found to be suitable for sludge conditioning of these 3 WWTPs. This could lead to an implication of reducing a significant amount of expensive cationic polymers for sludge conditioning at these plants.

Conditioning methods using other chemicals (besides cationic polymers) which are also promising solutions for replacing expensive conditioners in the WWTPs were demonstrated to improve sludge dewaterability in term of CST. However, full – scale trials or MCI test are needed in the future study to confirm this finding.